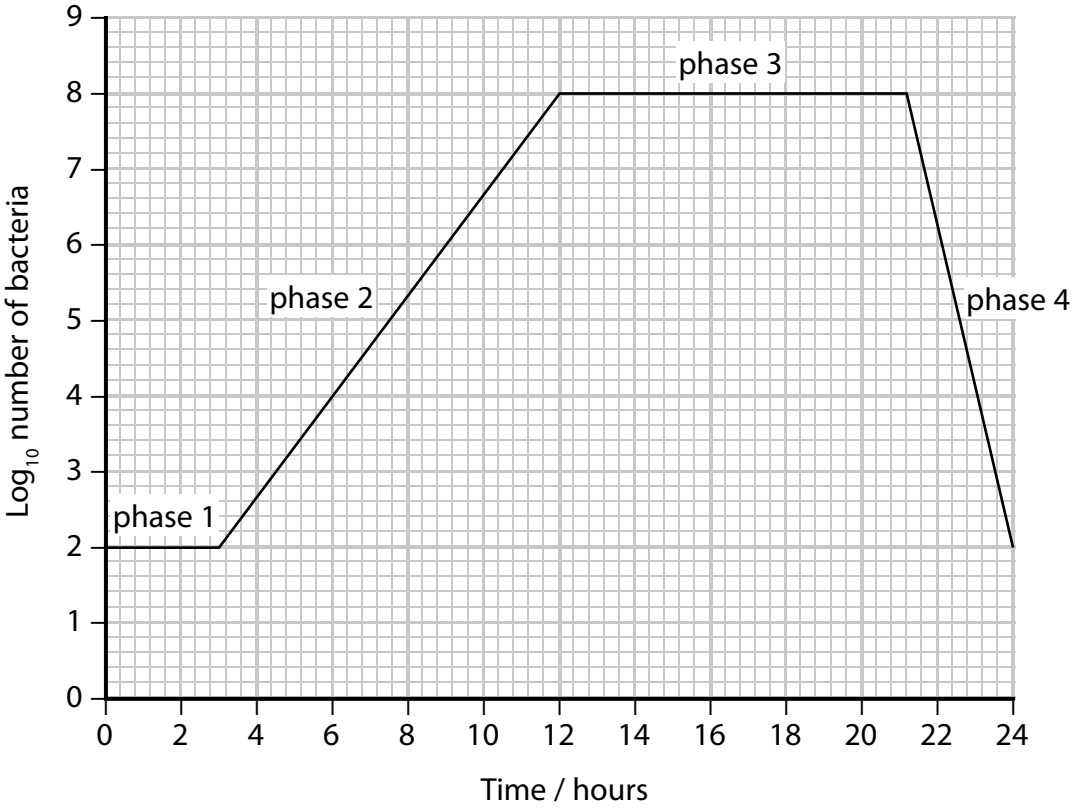
8 A broth culture for growing bacteria was set up.

Dilution plating was used to determine the number of live bacteria in the culture over a period of 24 hours.

The graph below shows the number of live bacteria in the culture during this 24-hour period.



(a) Which is the correct order of the phases 1 to 4 shown on the graph?

(1)

- ☒ **A** lag, log, death, stationary
- ☒ **B** lag, log, stationary, death
- ☒ **C** log, lag, death, stationary
- ☒ **D** log, lag, stationary, death

*(b) Evaluate the use of dilution plating and optical methods for determining the number of bacterial cells in a culture.

(6)

(c) Calculate the growth rate constant (k) for phase 2 of this culture, using the formula:

$$k = \frac{\log_{10} N_t - \log_{10} N_0}{0.301 \times t}$$

(4)

Answer .....

(Total for Question 8 = 11 marks)

8 A student investigating the factors affecting the heart rate of humans carried out a trial to find out the most reliable method of counting the number of heartbeats in one minute.

She counted the number of pulses in one minute of a single subject in identical conditions using two different methods.

Method A – she counted the number of pulses for 15 seconds and multiplied the result by 4.

Method B – she counted the number of pulses continuously for one minute.

The table below shows the results of six trials for each method.

Method	**Pulse rate / beats min^{-1}**						**Mean pulse rate / beats min^{-1}**	**Standard deviation**
A	64	60	68	76	64	72	67.3	5.9
B	63	59	69	58	71	74	65.7	

(a) The student calculated the standard deviation for method A using the following formula:

$$\sigma = \sqrt{\frac{\Sigma[x - \overline{x}]^2}{n - 1}}$$

Calculate the standard deviation for method B.

(3)

Answer .....

(b) Explain why standard deviation is used for analysing the data.

(3)

(c) Explain why both methods **A** and **B** can lead to inaccuracies.

(3)

(Total for Question 8 = 9 marks)